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(11) **EP 0 711 929 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
15.05.1996 Bulletin 1996/20

(51) Int. Cl.<sup>6</sup>: **F16C 33/30**, F16C 19/00

(21) Application number: 95203039.3

(22) Date of filing: 08.11.1995

(84) Designated Contracting States:  
DE FR GB

(30) Priority: 09.11.1994 NL 9401873

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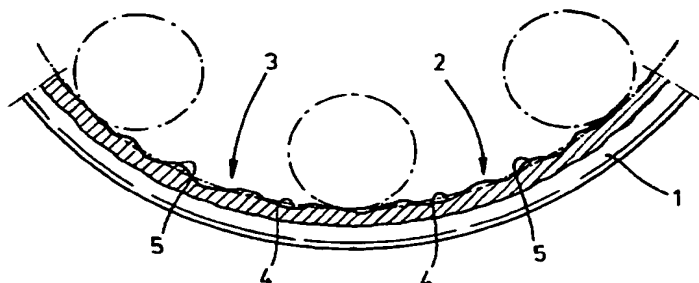
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(54) **Rolling element bearing having improved wear characteristics**

(57) A rolling element bearing comprises an outer ring (1) and an inner ring which enclose a bearing space containing rolling elements, which rings consist of steel. At least one of the rolling elements consists of a material which is harder or stiffer than the material of the other rolling elements. Any indentations, in particular the projecting parts (5) thereof, which are formed by solid contamination particles upon compression between the race in question and an rolling element of about the same

hardness, are now compressed as soon as a rolling element with a substantially higher hardness overrolls them. Thereby, said smooth character of the raceways is restored. Only small holes (4) are left, which do not have a reduced or no negative influence on the running properties of the bearing. In these small holes (4) minute quantities of lubricating oil are collected, which help the lubrication of the rolling element in case of oil starvation.

fig-1



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## Description

The invention is related to a rolling element bearing, comprising an outer ring and an inner ring which enclose a bearing space containing rolling elements, which rings consist of steel. Normally, the rolling elements of such bearing are of steel as well, in particular of steel with about the same hardness properties as the steel of the rings.

During rotation of the bearing, the rolling elements roll over the races of the rings. Any contaminations, for instance small wear particles, which are on the races or the rolling elements become compressed between these elements. Hard wear particles, for instance small steel particles which have come off of one of the components of the bearing or have entered from the outside, resist such compression and lead to the formation of minute indentations in both the races and the rolling elements.

It has been found that in particular the indentations in the races have a negative influence on the useful bearing life. Also, they lead to increased noise during running due to unsmooth running and increased play, caused by wear of the raceway surfaces.

These indentations take a craterlike shape, whereby a small central hole is surrounded by a ridge of material that has been pushed upwardly and projects above the raceway. Conversely, the rolling elements are indented as well. Due to the cyclic character of the load exerted by the rolling elements, crack formation and fatigue may occur in the rings at the location of high stress concentration usually located just under the ridge of a dent.

Although it has already been proposed to protect the bearings against such detrimental contamination particles by providing seals and filters, nevertheless the ingress thereof cannot always be totally prevented and therefore the formation of indentations cannot be excluded.

The object of the invention is therefore to alleviate the consequences of the occurrence of such indentations. This object is achieved in that at least one of the rolling elements consists of a material which is harder than the material of the other rolling elements.

Any indentations, in particular the projecting parts thereof, which are formed by solid contamination particles upon compression between the race in question and an rolling element of about the same hardness, are now compressed as soon as a rolling element with a substantially higher hardness overrolls them. Thereby, said smooth character of the raceways is restored. Only small holes are left, which do not have a reduced or no negative influence on the running properties of the bearing. In these small holes minute quantities of lubricating oil are collected, which help the lubrication of the rolling element in case of oil starvation. Also, the stress concentration and thus the risk of crack formation and wear is basically reduced. Furthermore, the bearing will run more quietly.

Although any material with adequate hardness properties (Vickers hardness at 5 kg load higher than 13 GPa and modulus of elasticity (Young's modulus) higher than

280 GPa) could be applied, preferably at least one of the rolling elements consists of a ceramic material i.e. engineering ceramic materials: silicon nitride including sialons, silicon carbide and aluminium oxide, or cermets such as cemented carbides. Normally, the other rolling elements consist of steel with about the same mechanical properties as the steel used in the rings.

Rolling element bearings wherein all rolling elements consist of ceramic material are already known. Having regard to the fact that in these bearings all rolling elements exert the same compressing action on the races, the development of such indentations with high ridges is prevented.

However, due to the higher hardness and stiffness properties of these rolling elements, the stresses induced in the rings are also higher thus leading to a reduced life or capacity for such types of bearings.

In the latter bearings, most of the rolling elements are made in steel; thus the deformation is shared equally between the contacting bodies leading to lower stress and preservation of the dynamic capacity of the bearing.

Most preferably, the ceramic material is silicon nitride.

In order to avoid unbalances in the rotating bearing, at least two rolling elements consisting of a harder material are provided which are regularly spaced in circumferential direction.

The invention will further be explained with reference to an embodiment shown in the figures.

Figure 1 shows a partly side view of an outer ring, having indentations, of a bearing with normal rolling elements.

Figure 2 shows a partly view of the outer ring, having small holes, in a bearing comprising at least one stiffer or harder rolling element.

The outer ring 1 of a rolling element bearing, the other parts of which have not been shown, has a raceway 2 over which the rolling elements may roll. Any solid contamination particles which get caught on the surface of the rolling elements and the raceway 2, will lead to the crater-like indentations, comprising a small hole 4 surrounded by a ridge or projecting part 5.

In turn, these projecting parts 5 will lead to stress concentration and to indentations in the rolling elements themselves.

The presence of such indentations in both the rings and the rolling elements of the bearing lead to early fatigue and crack formation. Also higher vibrations and a noisy running of the bearing are obtained.

According to the invention, at least one of the rolling elements is of substantially harder or stiffer nature, e.g. is made of a ceramic or cemented carbides. Such rolling element, when overrolling the indentations 3, will compress at least the protruding parts 5 thereof, as shown in figure 2.

In this figure 2, an outer ring 6 is shown, of which the projecting parts have been compressed down, giving rise to lands 7 which correspond to the normal, non-dam-

aged surface 8 of the ring 6. The holes which are formed by the indentations are left over.

The risk of fatigue and therefore crack formation and wear in ring of a bearing having at least 1 stiffer or harder rolling element is considerably lower than in the normal bearings. The presence of the small holes 4 leads to a better lubricating of the raceway 8 and the rolling elements. In the holes 4 minute amounts of oil 9 are collected, which give better lubricating characteristics.

#### Claims

1. Rolling element bearing, comprising an outer ring and an inner ring which enclose a bearing space containing rolling elements, which rings consist of steel characterised in that at least one of the rolling elements consists of a material which is harder or stiffer than the material of the other rolling elements.
2. Bearing according to claim 1, wherein the Vickers hardness measured at 5 kg load of at least one of the rolling elements is higher than 13 GPa
3. Bearing according to claim 1 or 2, wherein the modulus of elasticity of at least one of the rolling elements is higher than 280 GPa.
4. Bearing according to claim 1, 2 or 3, wherein at least one of the rolling elements consists of an engineering ceramic material or cermets, and the other rolling elements consist of steel.
5. Bearing according to claim 4, wherein the ceramic material is silicon nitride, sialons, silicon carbide, aluminium oxide or cemented carbides.
6. Bearing according to claim 1, 2, 3, 4 or 5, wherein at least two rolling elements consisting of a harder material are provided which are regularly spaced in circumferential direction.

fig - 1

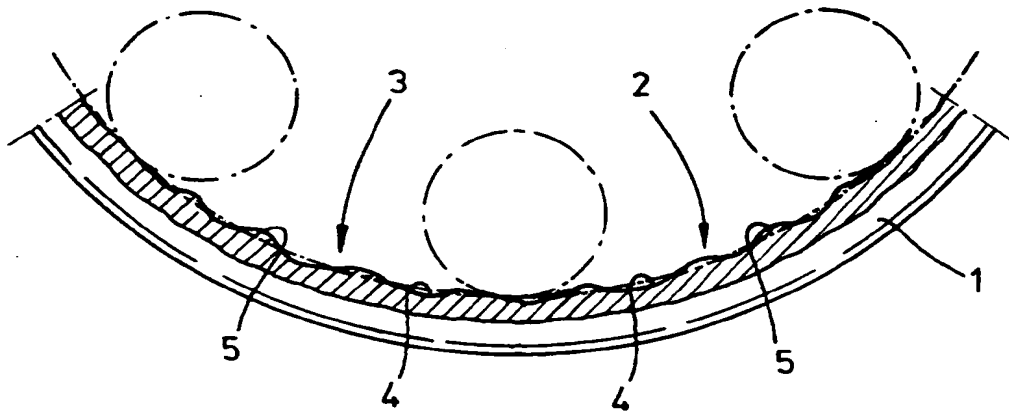
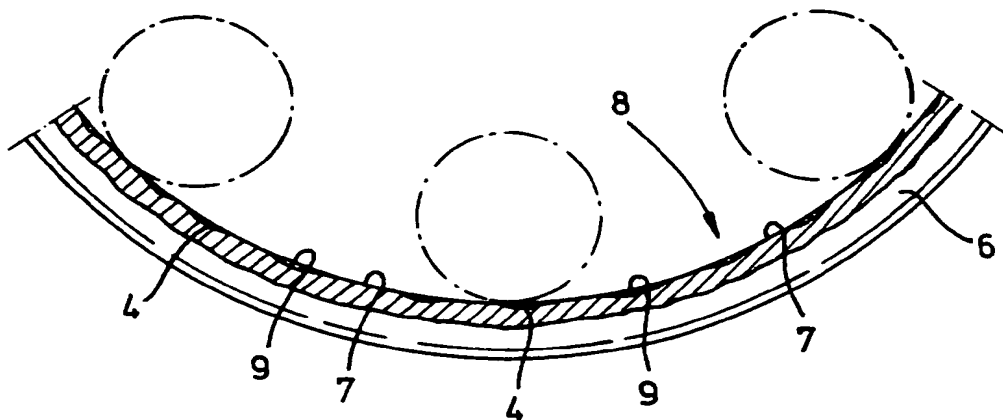


fig - 2





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# EUROPEAN SEARCH REPORT

Application Number  
EP 95 20 3039

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 304 872 (KOYO SEIKO) * page 3, line 5 - line 7 *	1,5	F16C33/30 F16C19/00
A	DE-A-25 11 120 (TELDIX) * the whole document *	1,5	
A	FR-A-2 479 369 (TORRINGTON) * the whole document *	1,6	
A	EP-A-0 238 725 (HOESCH) * the whole document *	1	
A	US-A-3 764 188 (SUSKA)		
A	GB-A-2 074 255 (NADELLA)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F16C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 February 1996	Examiner Orthlieb, C
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... &amp; : member of the same patent family, corresponding document</p>			

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